Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

AMS Tracker Thermal Control Subsystem

HX QM/FM He leak test and proof test procedure

AMSTR-NLR-PR-053
ISSUE 01
06 JULY 2008

Sun Yat-Sen University (SYSU)
National Aerospace Laboratory (NLR)
Instituto Nazionale di Fisica Nucelare (INFN)

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AUTHORISED	P. Dieleman	NLR Space Department		07/07/08

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Document change log

Change Ref.	*Section(s)*	*Issue 1.0*
-	All	Initial issue based partly on PR-003 Remark: Issue 1.0 does not contain the proof pressure test. This will be implemented in Issue 2. Issue 1.0 will be used for He-leak testing until HX welding

Summary

This document describes the quality check of the QM and FM HX brazing. The document contains the description of the parts and the quality checks. The quality check consists of He-leak tests and visual inspection of the parts.
The content includes the step 7, 11, 16 and 17 requested from the overall sequence of the HX manufacturing, as described in RD-2:

2. Cut soldering sheets in correct shape
3. Vacuum brazing stack of plates
4. Cover all entrances to avoid particle contamination
5. Measure the dimensions of the soldered stack of plates
6. Turning and machining of stack of plates to final dimensions
7. **Perform He-leak test on stack of plates**
8. Clean & cleaning check HX parts (stack of plates on outside, and container part)
9. Vacuum brazing (lower temperature as previous brazing) stack of plates to housing
10. Visual inspection after brazing on cleanliness
11. **He-leak test to check stack to container solder**
12. Visual inspection on cleanliness
13. Clean storage of brazed assembly
14. Cleaning before welding
    a. Cleaning check on combined brazed assembly
    b. Clean & cleaning piece 13.1 prior to welding
15. Weld HX orbital welding according to AMSTR-NLR-PR-54
16. **He leak test check solder connection of the stacked plates**
17. Turn the HX container with grooves for the start-up wire heater installation
18. **He leak test container, Proof pressure test, He-leak to check weld leak tightness and verify proof pressure.**

Contents

(26 pages in total)

1 Scope of the document

The procedure in this document describes the He-leak test of the brazing of the QM and FM heat exchanger after brazing step 1 (brazing stack of plates) and after step 2 (brazing stack of plates to container. After the HX welding step the leak tightness of the brazing is repeated. Subsequently a He–leak test, proof pressure test , and He-leak test are performed to show the integrity of the HX weld.

2 References documents

	Title	Number	Date
RD-1	TTCS Leak rate	AMSTR-NLR-TN-046-Issue 1.0	April 2006
RD-2	TTCS HX Manufacturing presentation, AIDC-meeting, Taichung		6 March 2007
RD-3	QM FM Heat Exchanger Brazing Procedure	AMSTR-NLR-PR-052-Iss02	July 2008
RD-4	TTCS Heat eXchanger design Report	AMSTR-NLR-TN-053 issue 1.0	February 2007
RD-5	Quality check procedure HX brazing test	AMSTR-NLR-PR-003	July 2007
RD-6	HX QM/FM Orbital welding procedure	AMSTR-NLR-PR-054	July 2008

3 Description of the items under test

3.1 Configuration after turning of the stack of plates

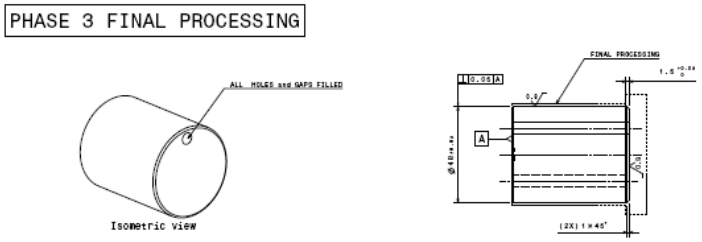


Figure 3-1: Stack of brazed HX plates prior to second brazing step

This configuration has one hole on one side and three holes on the other side.

3.2 Configuration after brazing the stack to the container part 14.1

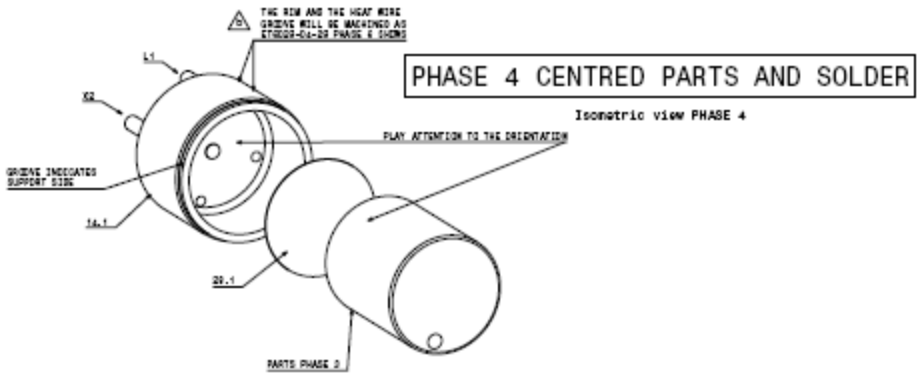


Figure 3-2: Stack and container part just prior to brazing

The configuration which will be He-leak tested is the integrated one. With the stack attached to the container part 14.1.

3.3 Configuration after welding

After welding the configuration looks like Figure 3-3. In this configuration a first He-leak test is performed to check no degradation of the brazing took place during welding. After that the container is turned with grooves for installing the start-up heaters. Right after turning the He-leak test on the container (and weld), the proof pressure and the second Helium leak test will be performed.

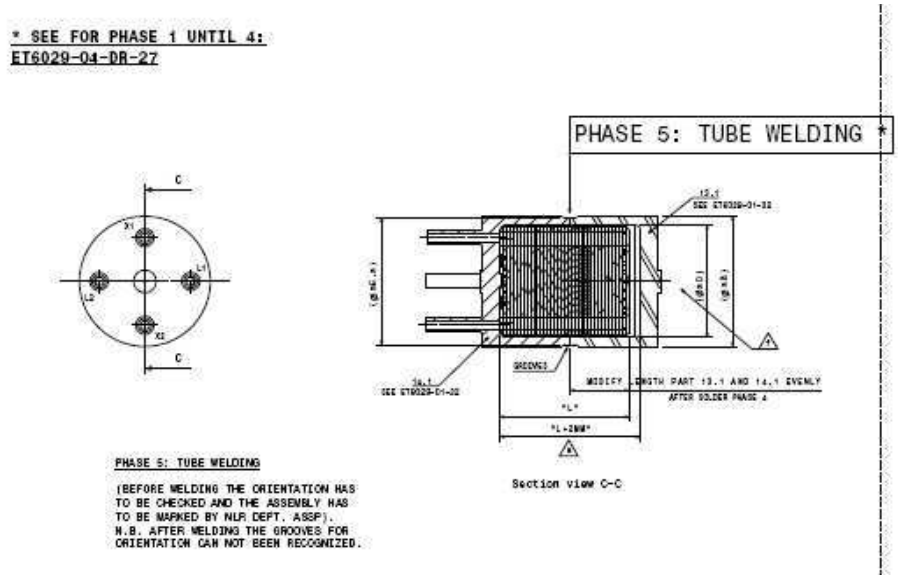


Figure 3-3: HX after welding

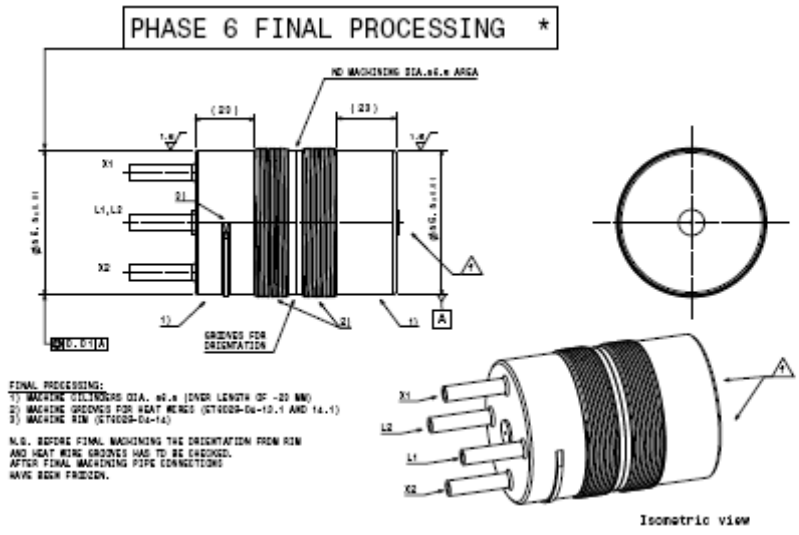


Figure 3-4: HX after welding and turning the grooves for the start-up wire heaters

4 He leak Check Test Procedure in main steps

The He-leak tests performed are done in several manufacturing steps of the HX assembly. In the subsequent subsections the main procedure steps for the separate manufacturing phases are listed.

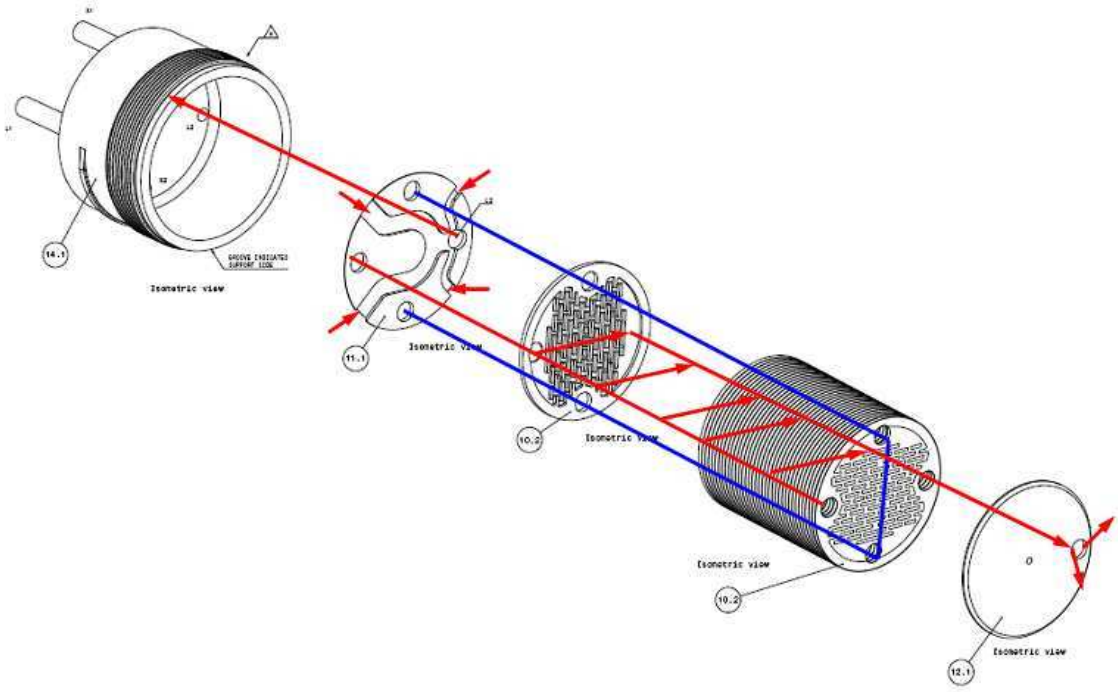


Figure 4-1: HX internal channel flow direction

4.1 He-leak test after turning

The He-leak test exists of two separate tests:

1. Leak tightness between the two-phase passages and the liquid passages
2. Leak tightness of the outside of the brazed HX-plate package to the liquid passage

4.2 He leak test after brazing the stack to the container part 14.1

This test consists of the same 2 steps.

1. Leak tightness between the two-phase passages and the liquid passages
2. Leak tightness of the outside of the brazed HX-plate package to the liquid passage

However the procedure is different as the pipes are now part of the assembly. This step is required to be sure the brazing is done well.

4.3 He leak tests & proof pressure test after welding

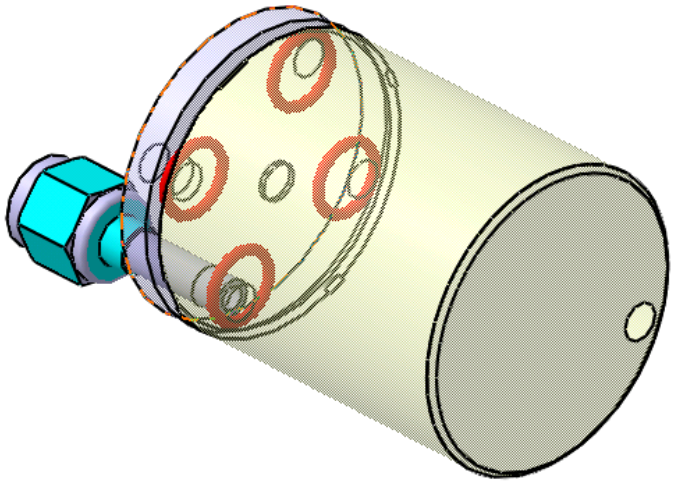
After welding first the He-leak test as in the previous configuration is repeated to check if the welding did not influence the stack brazing. It can be performed in almost the same way as in the former subsection.

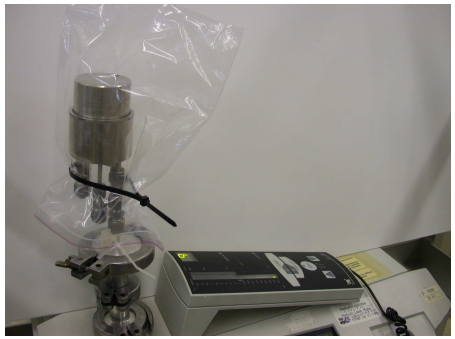
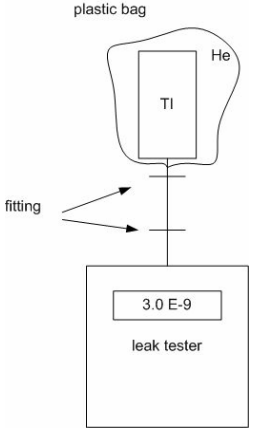
1. Leak tightness between the two-phase passages and the liquid passages
2. Leak tightness of the outside of the brazed HX-plate package to the liquid passage

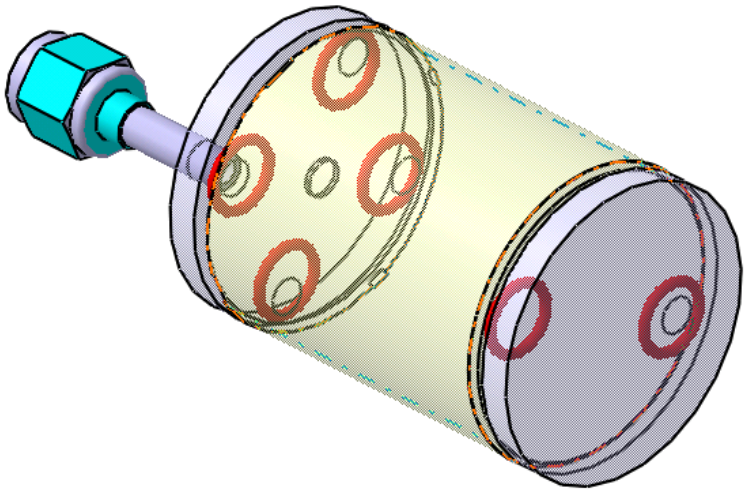
After the He-leak test a proof pressure test is performed on 240 Bar (= 1.5 * 160 bar (MDP)). Finally again a He-leak test is performed to demonstrate the proof pressure test did not impact the leak tightness of the HX.

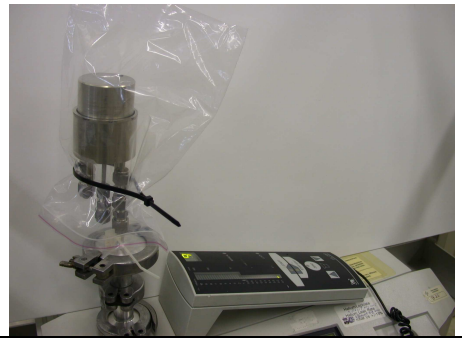
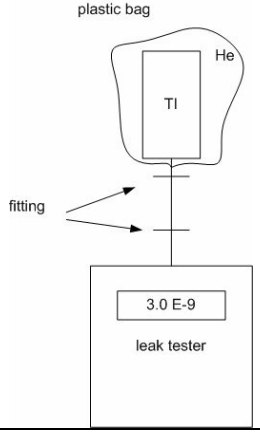
4.4 Helium leak test procedure after turning of stack of plates

	He leak test procedure sheet TTCS Heat Exchanger brazing plates		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
1.	Record Test Item description.	T.I. description	-			
2.	Record model (EM / QM / FM)	model	-			
3.	Record test equipment used	manufacturer, type	-			
4.	He leak test: Measure equipment background level (put cap on tester, without test item being connected)	background He-leak rate	$< 2*10^{-10}$ mbarl/s			
5.	Clean test equipment which will be in contact with the test item with clean IPA and a cloth					
6.	Perform a visual inspection no particles are found on this test equipment. If particles are found repeat step 5.					
7.	**Connect the Test Item to He leak tester as shown in the next steps**		-			
8.	Use C-clamp to fix test part with O-ring and support tool.					

	He leak test procedure sheet TTCS Heat Exchanger brazing plates		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
						
9.	Connect the tube to the Helium leak tester.					
10.	He leak test: Measure leak rate value without spraying helium.	background He-leak rate	$< 5*10^{-10}$ mbarl/s			
11.	He leak test: Cover the test part with a plastic bag and measure leak rate value when the bag is filled with helium. The set-up is shown in the figure and scheme below.	He leak rate to outside	$< 1*10^{-9}$ mbarl/s			

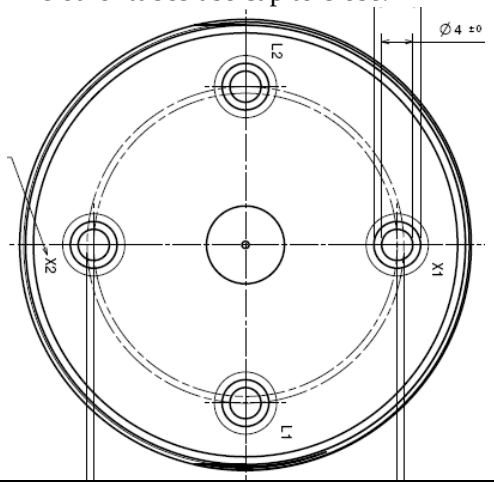
	He leak test procedure sheet TTCS Heat Exchanger brazing plates		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
	 					
12.	Remove connector and C-clamp.					
13.	Use C-clamp to fix test part with O-ring and support tool.					

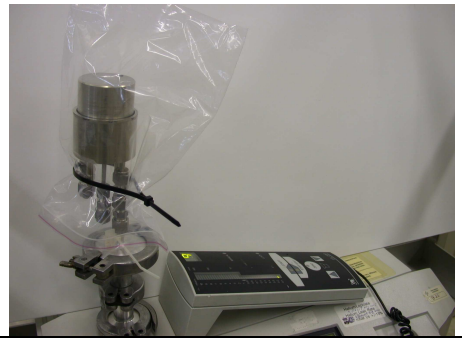
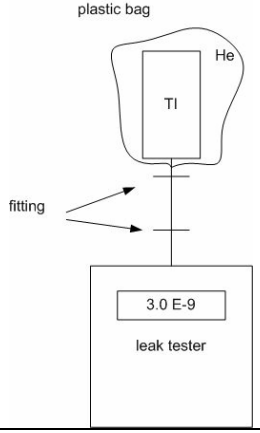
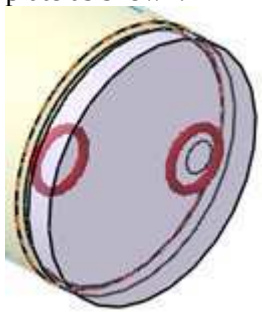
	He leak test procedure sheet TTCS Heat Exchanger brazing plates		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
						
14.	Connect the tube to the Helium leak tester.					
15.	He leak test: Measure leak rate value without spraying helium.	background He-leak rate	$< 5*10^{-10}$ mbarl/s			
16.	He leak test: Cover the test part with a plastic bag and measure leak rate value when the bag is filled with helium. The set-up is shown in the figure and scheme below.	He leak rate to outside	$< 1*10^{-9}$ mbarl/s			

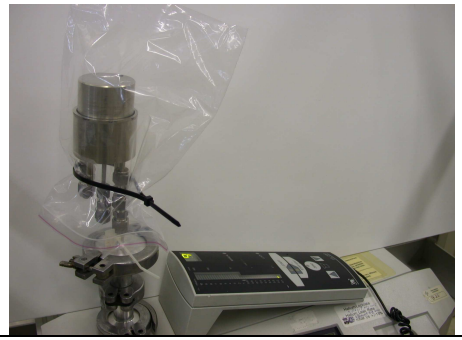
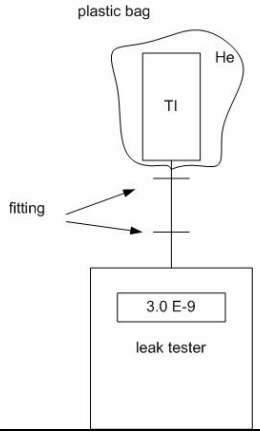
	He leak test procedure sheet TTCS Heat Exchanger brazing plates		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
	 					
17. 18. 19.	Remove connector and C-clamp. Close all the enterance using 3M 851 or 850 Tape. End					

4.5 He-leak test after second brazing step

	He leak test procedure sheet TTCS Heat Exchanger 2nd brazing part		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
1.	Record Test Item description.	T.I. description	-			
2.	Record model (EM / QM / FM)	model	-			
3.	Record test equipment used	manufacturer, type	-			
4.	He leak test: Measure equipment background level (put cap on tester, without test item being connected)	background He-leak rate	< $2*10^{-10}$ mbarl/s			
5.	Clean test equipment which will be in contact with the test item with clean IPA and a cloth					
6.	Perform a visual inspection no particles are found on this test equipment. If particles are found repeat step 5.					
7.	**Connect the Test Item to He leak tester as shown in the next steps**		-			
8.	Install 6mm Swagelok fitting with PTFE ferrule on 4 tubes.					

	He leak test procedure sheet TTCS Heat Exchanger 2nd brazing part		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
9.	Connect X2 tube to the Helium leak tester. The other tubes use cap to close. 					
10.	He leak test: Measure leak rate value without spraying helium.	background He-leak rate	< $5*10^{-10}$ mbarl/s			
11.	He leak test: Cover the test part with a plastic bag and measure leak rate value when the bag is filled with helium. The set-up is shown in the figure and scheme below.	He leak rate to outside	< $1*10^{-9}$ mbarl/s			

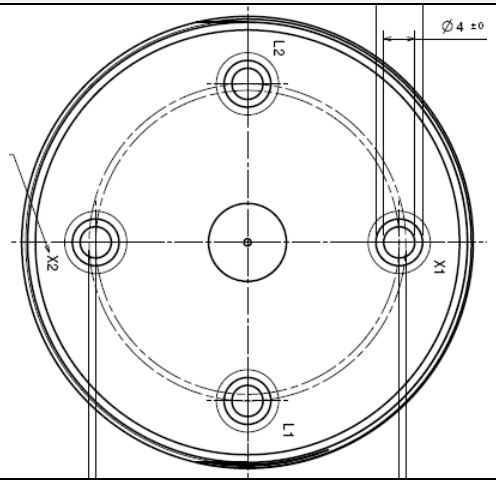
	He leak test procedure sheet TTCS Heat Exchanger 2nd brazing part		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
	 					
12.	Close the indicated inlet by clamping a rubber O-ring and a metal plate as shown: 					

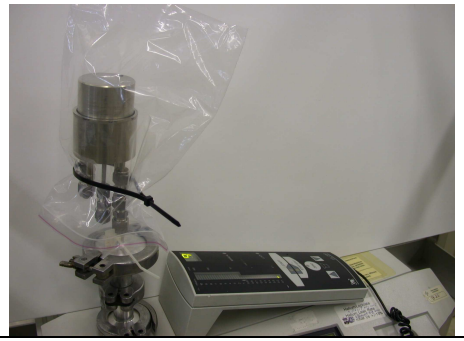
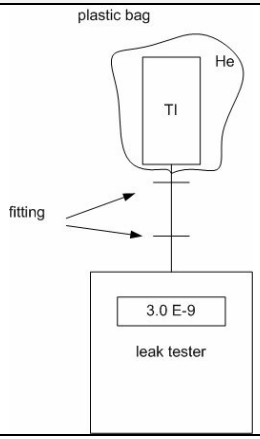
	He leak test procedure sheet TTCS Heat Exchanger 2nd brazing part		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
13.	Connect L1 tube to the Helium leak tester. The other tubes using cap to close.					
14.	He leak test: Measure leak rate value without spraying helium.	background He-leak rate	< $5*10^{-10}$ mbarl/s			
15.	He leak test: Cover the test part with a plastic bag and measure leak rate value when the bag is filled with helium. The set-up is shown in the figure and scheme below.  	He leak rate to outside	< $1*10^{-9}$ mbarl/s			

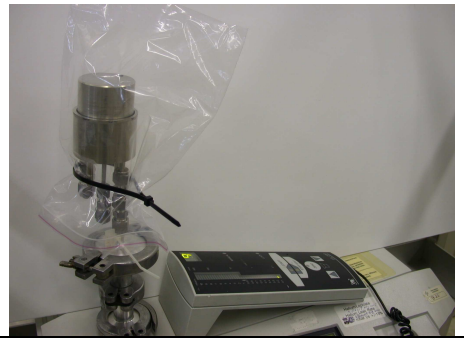
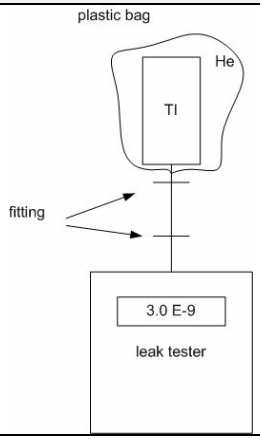
	He leak test procedure sheet TTCS Heat Exchanger 2nd brazing part		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
16.	Disconnect test part and remove C-clamp.					
17.	Close all the enterance using 3M 851 or 850 Tape & all the tubes using cap.					
18.	end					

4.6 He-leak test after orbital welding and proof pressure test

	He leak test procedure sheet TTCS Heat Exchanger		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
1.	Record Test Item description.	T.I. description	-			
2.	Record model (EM / QM / FM)	model	-			
3.	Record test equipment used	manufacturer, type	-			
4.	He leak test: Measure equipment background level (put cap on tester, without test item being connected)	background He-leak rate	< $2*10^{-10}$ mbarl/s			
5.	Clean test equipment which will be in contact with the test item with clean IPA and a cloth					
6.	Perform a visual inspection no particles are found on this test equipment. If particles are found repeat step 5.					
7.	**Connect the Test Item to He leak tester as shown in the next steps**		-			
8.	Connect X2 tube to the Helium leak tester. The other tubes using cap to close.					

	He leak test procedure sheet TTCS Heat Exchanger		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
						
9.	He leak test: Measure leak rate value without spraying helium.	background He-leak rate	< $5*10^{-10}$ mbarl/s			
10.	He leak test: Cover the test part with a plastic bag and measure leak rate value when the bag is filled with helium. The set-up is shown in the figure and scheme below.	He leak rate to outside	< $1*10^{-9}$ mbarl/s			

	He leak test procedure sheet TTCS Heat Exchanger		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
	 					
11.	Connect L1 tube to the Helium leak tester. The other tubes use cap to close.					
12.	He leak test: Measure leak rate value without spraying helium.	background He-leak rate	< $5*10^{-10}$ mbarl/s			
13.	He leak test: Cover the test part with a plastic bag and measure leak rate value when the bag is filled with helium. The set-up is shown in the figure and scheme below.	He leak rate to outside	< $1*10^{-9}$ mbarl/s			

	He leak test procedure sheet TTCS Heat Exchanger		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
	 					
14.	Disconnect the test part.					
15.	Close all the tubes using cap.					
16.	end					

4.7 Information on Helium Vacuum test method

The vacuum method is the most sensitive leak detection technique.

Two sub methods can be distinguished. Only the Helium outside vacuum inside method is described here.

4.7.1 Helium outside, vacuum inside

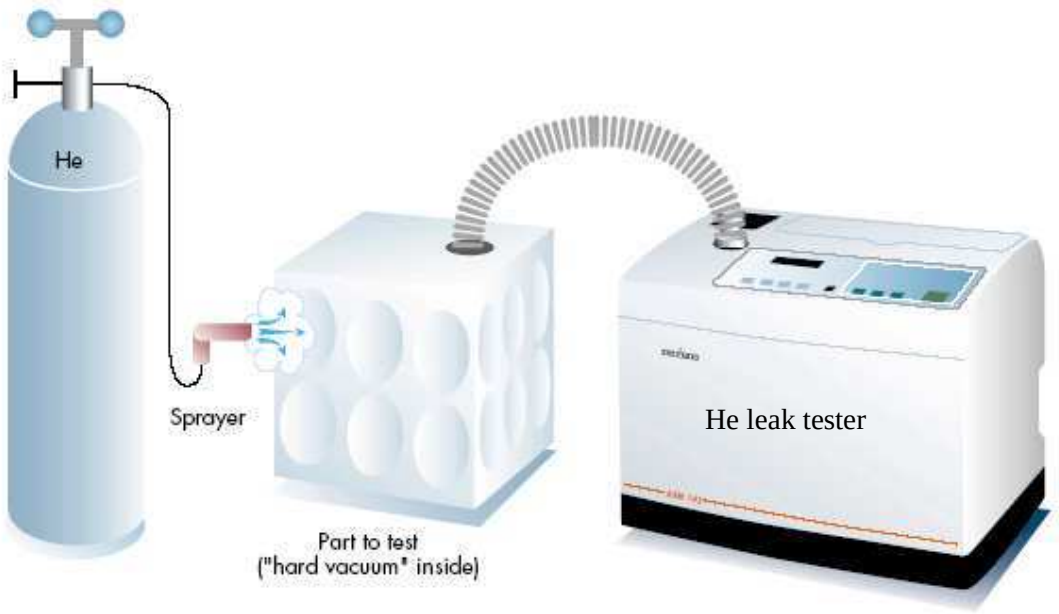


Figure 4-1: He leaktest, vacuum method

When this method is applied the object to be examined for leaks is evacuated and sprayed from the outside with a search gas, helium. The side which is placed under vacuum is connected to the leak detector. The gas enters through any leaks present in the object and is detected by a sensor connected to the leak test instrument. **Quantitative overall leak measurements can be performed by covering the test item with a bag and saturate the inside with helium.** Excessive use of helium shall be avoided as it will increase the detector's background detection level (decrease its leak test sensitivity). The helium that leaks into the test item is monitored and should be less than the required value.

State of the art helium leak rate testers can measure leak rates in the order of $1*10^{-10}$ mbar.l/s, however one should keep in mind that this value is often very difficult to obtain in practical situations. Very little helium contamination already can disturb the background detection level.

END OF DOCUMENT